METHOD AND APPARATUS FOR DETERMINING LOAD LEVEL IN A COMMUNICATION SYSTEM

BACKGROUND

I. Field of the Invention

The present invention relates to wireless communications. More particularly, the present invention relates to a novel and improved method and apparatus for determining load level of reverse link communications in a code division multiple access (CDMA) communication system.

II. Background

In general, communication services provided by a cellular communication system are in a cell format and/or sector format. The terms cell and sector are interchangeable in the way communication services are provided. In each cell, the communication system has an independent base station (BS) that provides the communication services to a number of mobile stations (MS). A BS controller is connected to one or more BSs. The BS controller connects to other BS controllers and a land-based voice/data network. The communication link between an MS and a BS may be in the form of a forward link from the base station to the MS and a reverse link from the MS to the base station.

In a CDMA system, an MS may increase its reverse link power level to maintain a constant data rate to compensate for the rise in the reverse link load level introduced by the reverse link signals of other MSs in the coverage area. Such MSs include devices such as a computer, a handheld communicator, and any other device capable of wireless communication (hereinafter all referred to as MSs). If the reverse link signal power level of a MS is kept constant, the data rate of the reverse link may be reduced alternatively to combat the rise in the reverse link load level. Combined power level of reverse link signals of one or

more MSs may be considered as the reverse link load level. An increase in the number of MSs with reverse link activities has approximately a linear effect on the rise of the reverse link load level when the reverse link load level is at a low level. At high reverse link load level, an increase or decrease in the number of MSs with reverse link activities in the coverage area causes a large fluctuation in the reverse link load level.

Referring to Fig. 1, a graph of reverse link load levels in the form of a percentage of the total acceptable load level versus the rise in the reverse link power level is shown. The rise above the noise floor is the aggregate of power levels of the reverse links. As more MSs enter the cell coverage area provided by a base station, the activity on the reverse link also increases. As such, the activity on the reverse link may be represented as a total rise in the reverse links power level above a noise level. The rise in power level has an asymptotic behavior with respect to the load. At a low range of the percentage of reverse link load, the rise in power level is approximately constant or linearly rises with the load. At a high range of the percentage of reverse link load, the rise in reverse links power level above noise level is asymptotic with respect to the load level, and, in theory, may reach infinity.

If the load level is high, allowing MSs in the coverage area may cause disruption of communication services provided to other mobile users due to the effects caused by the large fluctuation in the reverse link load level. For example, all MSs attempting to maintain a data rate may have to increase their power level to combat the rise in the load level caused by allowing more MSs to operate in the coverage area. Such a rise in power level by the MSs would aggravate the reverse link load level to a higher level, which may cause breakdown of the communication services in the coverage area because the communication capacity of the reverse link is limited.

There are several problems with determining the reverse link load level in an effort to limit reverse link access to the base station. These problems include expenses associated with the needed measurement hardware and software; the necessity to conduct the difficult task of measuring the noise floor;

lack of accurate information on the number of MSs in the coverage area; and the possibility of having to determine data rates of the communications between the MSs and the base station.

In general, it is desirable to determine the reverse link load level. Additionally, it is desirable to increase the reliability of the base station to provide stable communication services at all possible load levels.

SUMMARY

The disclosed novel and improved method is for determining load level of reverse link communications of a communication system. In one aspect, the communication system includes at least a base station for providing communication services to a number of MSs through at least reverse link signals. A method and the accompanying apparatus for determining reverse link communications load level of the communication system includes receiving the reverse link signals from the number of MSs. Each reverse link signal carries at least a pilot channel, a reverse link rate indicator channel and a data channel. The data channel may be referred to as a traffic channel. For each received reverse link signal, the method and accompanying apparatus includes (a) determining a first signal power ratio of the pilot channel power level over the received reverse link total power level; (b) determining reverse link rate indicator information carried by the received reverse link rate indicator channel; (c) determining, based on the reverse link rate indicator information, a predetermined ratio of the traffic channel power level to the pilot channel power level; (d) scaling the first signal power ratio by the predetermined ratio to determine a second signal power ratio of the traffic channel over the received reverse link signal power level. The method and the accompanying apparatus provides for summing the second signal power ratio for each of the received reverse link signals to determine the reverse link communication load level of the communication system.

BRIEF DESCRIPTION OF THE DRAWINGS

The features, objects, and advantages of the present invention will become more apparent from the detailed description set forth below when taken in conjunction with the drawings in which like reference characters identify correspondingly throughout and wherein:

FIG. 1 depicts a graph of reverse link load levels in the form of percentage of the total acceptable load level versus rise in the reverse link power level;

FIG. 2 depicts a block diagram of a communication system;

FIG. 3 depicts a block diagram of the reverse link transmitter;

FIG. 4 depicts a table for data channel gain relative to pilot channel power level for different data rates;

FIG. 5 depicts a block diagram of a demodulator used for processing CDMA signals, such as reverse link signals; and

FIG. 6 depicts a flow chart of an exemplary series of steps needed to determine the load and the rise of the reverse link.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A novel and improved method and apparatus for determining load level of reverse link communications of a communication system is described. The exemplary embodiment described herein is set forth in the context of a digital cellular telephone system. While use within this context is advantageous, different embodiments of the invention may be incorporated in different environments or configurations. In general, the various systems described herein may be formed using software-controlled processors, integrated circuits, or discrete logic. The data, instructions, commands, information, signals, symbols, and chips that may be referenced throughout the application are advantageously represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or a combination thereof. In addition, the blocks shown in each block diagram may represent hardware or method steps.

Referring to Fig. 2, a simplified block diagram of a communication system 200 is shown. A base station controller (BSC) 14 may be connected to a voice/data network 16. BSC 14 may also be connected to other base station controllers, shown by dotted lines. A mobile station controller (not shown) may also control BSC 14 and other BSCs (not shown). BSC 14 controls one or more base station transceivers (BS), shown as BS 201-03. Each BS 201-03 has an associated hardware such as a system of antenna, receiver, transmitter, controller and operating software to maintain communication links with a number of MSs (MS), such as MS 210-11. Each BS 201-03 provides communication services in a coverage area. The coverage area for each BS may be different in size and shape. There may also be overlap of coverage areas. A system such as communication system 200 is capable of providing communication services to a large number of MSs even though only two MSs 210 and 211 are shown.

When a MS is in a coverage area and transmitting on the reverse link, the MS adds to the rise of the reverse link load level. The MS, even though in a coverage area of a BS, may not be in communication with the BS. If the MS is not in communication with the BS, the BS has no reliable way of knowing whether the MS is in the coverage area and whether the MS is transmitting. If the MS is in the coverage area and transmitting on the reverse link but not received by the BS, the reverse link load level may be erroneously determined by not including the rise in the power level associated with the undetected MS. Since large fluctuations of power level may result at high percentage load level, an erroneous determination of reverse link power level may cause severe and detrimental disruption of the communication services.

Referring to Fig. 3, a block diagram of a reverse link transmitter 300 is shown. The reverse link may have four channels, namely a pilot channel 301, a reverse link rate indicator (RRI) channel 302, a data rate control (DRC) channel 303, and a traffic/control data channel 304. Each channel is independently Walsh covered, possibly time multiplexed with other channels, and processed before being summed for transmission from reverse link transmitter 300.

Reverse link transmitter 300 may also include any commonly known radio frequency up-converter and linear amplifier (not shown) suited for transmission of CDMA signals. A linear amplifier is used for amplifying the signal before transmission from an antenna (not shown) coupled thereto. The information on pilot channel 301 which may include all zeros is mapped in a signal point mapping 305. The mapped signal is Walsh covered in a multiplier 306 before presented to a time division multiplexed (MUX) block 307. The pilot information extracted by a receiver after reception of pilot channel 301 is used to determine the propagation channel characteristics, which are helpful in decoding the information transmitted on other channels.

The information on RRI channel 302 is modulated, passed through symbol repetition, signal point mapping, and Walsh covering, respectively, in blocks 308-11. The results are presented to MUX block 307. The RRI information is used by the BS to determine the data rate at which the MS is transmitting on reverse traffic channel 304. The RRI information is very helpful in data communication because the data rate on the reverse link may vary from 4.8 to 153.6 Kbps in different increments in accordance with an embodiment. For example, there may be six or more possible data rates. Without the RRI information, the receiver may spend a lot of time decoding the data at different rates before deciding the actual transmitted data rate. The data rate is represented by a three-bit RRI symbol. In block 308, each RRI symbol maps into an 8-ary Walsh orthogonal code word and then is transmitted, possibly twice per time slot. The RRI code words are further spread by Walsh cover to yield 64-chip long RRI channel symbols. The RRI channel symbols are punctured into pilot channel 301 at the beginning of every time slot. The RRI channel symbols are transmitted during the first 16 slots of a packet, once per slot. The inverse of the RRI channel symbols may be transmitted during the second 16 time slots, although this is not required. Whenever the MS is not transmitting on the reverse traffic channel, RRI channel 302 transmits null (zero) symbols. The RRI channel 302 may have different configurations for informing the BS of the reverse link data rate.

DRC channel 303 reports to the BS the requested data rate of the forward link traffic channel. The MS may make the data rate request. The DRC symbols are encoded in an encoder 312, then repeated in a symbol repetition block 313, mapped in a signal mapping block 314 and Walsh covered by a multiplier 315 before being presented to MUX block 307. The requested data rate may be determined based on the quality of received signals at the MS. The carrier to interference (C/I) ratio of the signals received from the BS serving the MS is determined and used as a quality factor for determining the requested data rate. The DRC channel 303 transmits a four-bit DRC symbol. The DRC symbol is transmitted over a number of times to yield a DRC symbol sequence at 600 symbols per second. Pilot channel 301, RRI channel 302 and DRC channel 303 are multiplexed in MUX block 307 to produce a signal 316 at 1.2288 Mcps.

In one embodiment, the traffic channel 304 is allowed to transmit at various data rates. Traffic data is encoded in an encoder block 317, then channel interleaved in a block 318, and repeated in a packet repetition block 319. The result is presented to a signal point mapping block 320 and passed through a channel gain block 321 before being Walsh covered in a multiplier 322. The gain adjustment in block 321 may depend on the traffic channel data rate. A resulting signal 317 is produced at 1.2288 Mcps.

The MS determines the needed power level on the reverse link to support both the traffic channel and the pilot channel. Various power control schemes for controlling power level of signals transmitted from a MS in a communication system are known. One such example is described in the Mobile Station-Base Station Compatibility Standard for Wideband Spread Spectrum Cellular Systems, otherwise known as TIA/EIA-95 standard, incorporated by reference herein. The output power level of the MSs is controlled by two independent control loops, open loop and closed loop. The open loop power control is based on the need of each MS to maintain an adequate communication link with the BS. Therefore, the MS closer to the BS needs less power than the MS further away. A strong receive signal at the MS indicates less propagation loss, and thus, requiring a weaker reverse link

transmit power level. In the open loop power control, the MS sets the transmit power level of the reverse link based on independent measurements of Ec/Io of at least one received channel, such as, e.g., pilot, paging, sync, and traffic channels. The MS may make the independent measurement prior to power level setting on the reverse link.

Closed loop power control begins to operate once the MS seizes a forward link traffic channel. After the initial access attempt by the MS, the MS sets an initial reverse channel power level. The initial power level setting on the reverse link is then adjusted during the communication link via the closed loop power level control. The closed loop power control operates with a faster response time than the open loop control. The closed loop power control provides correction to the open loop power control. The closed loop power control in conjunction with the open loop control during a traffic channel communication link may provide reverse link power control with over 80 dB dynamic range.

The closed loop power control has an inner-loop power control and an outer-loop power control. The inner-loop power control keeps the reverse link (Eb/It) at the MS as close as possible to its target thresholds. The outer-loop control keeps at the BS a target Eb/It threshold given to the MS. On the forward link through the inner-loop power control, the BS transmits on the power control subchannel power control bits to the MS. The BS measures the Eb/It of the reverse link during each power control group, and compares the result to a threshold. Based on the comparison, the BS transmits a power control bit indicating power up or down of the reverse link signal. A single threshold may not be satisfactory for all conditions; therefore, the threshold may also change depending on a desired reverse link frame error rate through the outer loop power control. The outer-loop power control may command once every frame, and closed loop, once every power control group. One frame and one power control group may be, respectively, 20 and 1.25 mSec long.

The system may also employ a forward link power control scheme to reduce interference. The MS communicates to the BS periodically about the

voice and data quality. The frame error rate and quality measurements are reported to the BS via a power measurement report message. The message contains the number of frames received in error on the reverse link during an interval. The power level of the forward link signal is adjusted based on the number of frame errors. Since such a quality measurement feedback is based on frame error rate, it is much slower than reverse link power control. For fast response, the reverse link erasure bit may be used to inform the BS whether the previous frame was received with or without error. The channel power gain may be continuously adjusted while monitoring the message or the erasure bit as a way of controlling forward link power level.

For communication of data, the forward link may be transmitted to the MS at a fixed power level while adjusting the effective forward link data rate targeted for the MS. The data rate adjustment on the forward link when viewed for the overall system is a form of interference control. Note that, the forward link power control is generally for controlling interference in a coverage area. When the feedback quality measurement is indicating poor reception, the data rate may be lowered while keeping the power level constant to overcome the effect of the interference. The data rate may also be lowered to allow other terminals to receive forward link communication at a higher data rate.

According to the CDMA-2000 Spread Spectrum Systems standard, incorporated by reference herein, in addition to the open loop and closed loop power control schemes, the MS adjusts the output power level by attributes of a code channel as specified by the standard. In CDMA-2000, the MS sets the output power of the enhanced access channel header, enhanced access channel data, and the reverse common control channel data relative to the output power level of the reverse pilot channel. The output power level of the reverse pilot channel is set by the open and closed loops power control. The MS maintains a power level ratio between the code channel power level and the reverse pilot channel power level. The ratio may be defined by the data rate used in the code channel. Generally, a table provides the values for the ratio at different data rates. The ratio is generally increases for higher data rates. During

transmission of data on a traffic channel, the data rate and the traffic channel power level may be adjusted. The power level may be selected based on a relative power of the reverse link pilot. Once an allowable data rate is selected, a corresponding channel gain with respect to the reverse link pilot power level is used to set the traffic channel power level.

The power level of traffic channel 304 as set by gain block 321 may be relative to power level of pilot channel 301. The relative channel gain is set uniquely for each data rate used on traffic channel 304. Referring to Fig. 4, a table 400 shows the gain of traffic channel 304 relative to the power level of pilot channel 301 for different data rates. Each ratio is defined by a fixed data-pilot ratio parameter, data-offset and a fixed number. For example, for the data rate 76,800 bps, the fixe number is equal to 9 dB.

Referring to Fig. 3 again, signals 316 and 317 are presented to a complex I&Q spreading block 330 to spread the signals according to spreading sequences PNI and PNQ. The results are filtered in base band filters 331 and 332. The outputs of filters 331 and 332 are subjected to an I&Q carrier spreader 333. A summer 334 sums the results of carrier spreader 333 to produce a reverse link signal 335. Signal 335 may pass through a linear amplifier and an antenna (not shown) for transmission to the BS on a reverse link transmission.

Fig. 5 is a block diagram of a demodulator used for processing CDMA signals, such as reverse link signals. Receive (Rx) samples are generated by an RF/IF system 590 and an antenna system 592. The received RF signals are filtered, downconvert, and digitize to forms samples at the baseband frequencies. The samples are supplied to a demultiplexer (demux) 502. The output of demux 502 is supplied to a searcher unit 506 and finger elements 508. A control unit 510 is coupled thereto. A combiner 512 couples a decoder 514 to finger elements 508. Typically, control unit 510 is a microprocessor controlled by software, and may be located on the same integrated circuit or on a separate integrated circuit.

During operation, receive samples are applied to demux 502. Demux 502 supplies the samples to searcher unit 506 and finger elements 508. Control unit

510 configures finger elements 508 to perform demodulation of the reverse link signal at different time offsets based on search results from searcher unit 506. The results of the demodulation are combined and passed to decoder 514, which outputs the data.

In general for searching, the searcher 506 uses non-coherent demodulation of pilot channel 301 to test timing hypotheses and phase offsets corresponding to various sectors, BSs, and multi-paths. The demodulation performed by finger elements 508 is performed via coherent demodulation of other channels such as RRI channel 302, DRC channel 303 and traffic channel 304. The information extracted by searcher 506 is used in finger elements 508 for demodulation of other channels. The searcher 506 and finger elements 508 may provide both pilot channel searching, demodulation of RRI, DRC and traffic channels. The demodulation and searching can be performed at various time offsets. The results of the demodulation for each channel may be combined in combiner 512 before decoding the data on each channel. Despreading of the channels is performed by multiplying the received samples with the complex conjugate of the PN sequence and assigned Walsh function at a single timing hypothesis and digitally filtering the resulting samples, often with an integrate and dump accumulator circuit. Such a technique is commonly known in the art.

In data mode, a BS may be providing communication link to a large number of MSs at different data rates. For example, one MS in a forward link connected state may be receiving data at a low data rate, and another receiving at a high data rate. On the reverse link, the BS may be receiving a number of reverse link signals from different MSs. A MS based on an independent measurement may decide and request a desired data rate from the BS. The desired forward link data rate is communicated to the BS via DRC channel 303. The BS attempts to provide a forward link data transfer at the requested data rate. On the reverse link, the MS may autonomously select a reverse link data rate from a number of possible reverse link data rates. The selected data rate is communicated to the BS via RRI channel 302. Each MS may also be limited to a

predetermined grade of service. A grade of service may limit the maximum available data rate on the forward and/or reverse links.

Communication of data at high data rates takes a greater transmit/receive signal power level than low data rates. The forward and reverse links may have similar data rate activities in case of voice communications. The forward and reverse links data rates may be limited to low data rates since the voice information frequency spectrum is limited. Possible voice data rates are commonly known and described in a code division multiple access (CDMA) communication system standard such as IS-95 and IS-2000, incorporated by reference herein. For data communications, however, the forward and reverse links may not have similar data rates. For example, a MS may be retrieving a large data file from a database. In such a case, the communication on the forward link is predominately occupied for transmission of data packets. The data rate on the forward link may reach 2.5 Mbps. The data rate on the forward link may be based on a data rate request made by the MS. On the reverse link, the data rate is lower, and may range from 4.8 to 153.6 Kbps. The range of possible data rates for data application is much wider than voice data rates. At a high percentage of reverse link load level, an increase or decrease in the data rate of reverse links in the coverage area has large fluctuation in the reverse link load level. Disruption of communication services at high load level may be more pronounced in data than voice communication applications.

In order for a MS to receive communication services, it may have to go through several logical states. The first state may be the initial access state for registering with the BS to set up a communication link. The next state may be the idle state in which the MS has completed the initial registration and protocol exchanges with the BS. In the idle state, the MS may wake up and initiate a communication link with the BS, either by a user of the MS or the BS. In the next state, the MS may be in a connected state. In the connected state, the MS is either receiving data or is waiting to receive data. There are periodic reverse link communications between the MS and the BS. To mitigate the effect of loss

of communication services at high load level, the BS may limit access at the initial state if the BS has a reliable information regarding the reverse link load level. The BS may also reduce the data rate of at least one reverse link to mitigate the effect loss of communications to other MSs.

According to an embodiment, the BS determines the reverse link load level by taking into the load calculation all MSs in the coverage area. Some MSs may and others may not be in communication with the BS via traffic data channel 304. A MS even though is transmitting on the reverse link may not be received by the BS, or at least, its traffic channel may not be decoded adequately to determine at least the communication data rate on the data channel. Calculation of the reverse link load requires knowledge of the data rates used by the MS on the reverse link. All MSs are included in the calculation of the reverse link load regardless of whether their data channel is being decoded at the BS for the determination of the reverse link data rate in accordance with an embodiment. The knowledge of the reverse link data rate is extracted from RRI channel 302, and is independent of whether the traffic channel 304 is decoded. The RRI channel may be received and decoded by the BS even though the data channel may not have properly been received and decoded.

The following notation definitions are helpful for derivation of certain equations and relationships shown throughout.

M : number of users on the reverse link,

$Load$: load level on the reverse link,

$Rise$: ratio of total reverse link power to noise power

N_T : total reverse link power that includes both noise power and the reverse link signal power.

N_0 : reverse link noise power

P_T : reverse link total signal power

P_i : total reverse link signal power for a user "i".

SNR_T : ratio of total reverse signal power to total power.

SNR_i : ratio of reverse signal power to total power for user i.

PNR_i: ratio of the reverse signal pilot power to total power for user i.

r_i: reverse link data rate for user i.

$\gamma_i[r_i]$: ratio of reverse link signal power to reverse link pilot power for user i at data rate r.

The relationship between load level of the reverse link (load hereinafter) and the rise of the reverse link power level above noise (rise hereinafter) may be derived by following the mathematical derivation as follows:

$$Rise = \frac{N_T}{N_0} = \frac{N_T}{N_T - \sum_{i=1}^{M} P_i} = \frac{1}{1 - \sum_{i=1}^{M} \frac{P_i}{N_T}} = \frac{1}{1 - \sum_{i=1}^{M} SNR_i} = \frac{1}{1 - SNR_T}.$$

The sensitivity analysis for the relationship between $Rise$ and SNR_T:

$$\frac{\partial Rise}{\partial SNR_T} = \frac{1}{(1 - SNR_T)^2} = Rise^2;$$

$$\frac{\partial Rise}{Rise} = Rise \bullet SNR_T \bullet \frac{\partial SNR_T}{SNR_T} = Rise \bullet \left(1 - \frac{1}{Rise}\right) \bullet \frac{\partial SNR_T}{SNR_T} = (Rise - 1) \bullet \frac{\partial SNR_T}{SNR_T}.$$

The relationship between $Load$ and SNR_T:

$$Load = 1 - \frac{1}{Rise} = SNR_T$$

The sensitivity analysis for the relationship between $Load$ and SNR_T:

$$\frac{\partial Load}{\partial SNR_T} = 1$$

$$\frac{\partial Load}{Load} = \frac{\partial SNR_T}{SNR_T}.$$

Relationship between $Rise$ and $Load$:

$$Rise = \frac{1}{1 - SNR_T} = \frac{1}{1 - Load}.$$

Referring to Fig. 6, a flow chart 600 shows an exemplary series of steps needed to determine the load and the rise of the reverse links. The rise and load determine the activities on the reverse links and their respective positions on an exemplary curve as shown in Fig. 1. If the rise and load show the load to be in the high percentage region of the curve, the BS may decide to deny access to the BS. A MS being denied access may be the new MSs roaming and/or already in the coverage area. Also, the BS may reduce the data rate of at least one reverse link to allow bring the load level in a low percentage region of the curve.

To determine the load and rise, at step 601, the BS measures the ratio of the signal power level of the reverse link pilot channel to the total power of the reverse link signal for each user (PNR_i). The receiver shown in Fig. 5 may be an exemplary receiver for performing step 601. Searcher 506 and/or in combination with finger element 508 may detect pilot channel 301 for each user. The power level for pilot channel 301 for each user may be measured using non-coherent demodulation for detection of signal strength. The reverse link signal total power may also be measure in a similar way. Control system 510 may perform the calculation for determining the ratio PNRi.

At step 602, the BS determines the data rate for each user (r_i) using explicitly the reverse rate indicator (RRI) information transmitted by each user on the reverse link RRI channel 302. A zero data rate or a minimum data rate, such as 9.6 Kbps, may be used if the RRI cannot be determined. The receiver shown in Fig. 5 may be an exemplary receiver for performing step 602. Searcher 506 and/or in combination with finger element 508 may detect RRI channel 302 for each user. The RRI information for each user may be determined using coherent demodulation. Use of combiner 512 and decoder 514 may be necessary to decode the RRI information. Determining the data rate based on the RRI information does not require decoding the traffic channel. Control system 510 may determine the data rate (r_i) based on the decoded RRI information.

At step 603, the BS determines a ratio ($\gamma_i[r_i]$). The ratio $\gamma_i[r_i]$ is a ratio of the signal power level of reverse link traffic channel 304 to the signal power level of reverse link pilot channel 301. This determination may be based on the determined data rate (r_i) by using a lookup table similar to the table 400, shown in Fig. 4. Note that, each data rate (r_i) is associated with a ratio ($\gamma_i[r_i]$).

At step 604, the BS scales the ratio of the measured pilot power to total power (PNR_i) by multiplying it by the ratio ($\gamma_i[r_i]$) to determine the ratio of the signal power of reverse link traffic channel 304 to the total power level of the reverse link for each user (SNR_i); that is, $SNR_i = \gamma_i[r_i]PNR_i$.

At step 605, the BS sums the ratio of signal power to total power (SNR_i) of all the users to determine the ratio of the reverse link signal power level to total reverse link power level (SNR_T). For M being the total number of users,

$$SNR_T = \sum_{i=1}^{M} SNR_i = \sum_{i=1}^{M} \gamma_i[r_i]PNR_i .$$

The load and its relationship to rise may be summarized as follows:

$$Rise = \frac{1}{1 - SNR_T} = \frac{1}{1 - \sum_{i=1}^{M} \gamma_i[r_i]PNR_i}, \text{ and}$$

$$Load = SNR_T = \sum_{i=1}^{M} \gamma_i[r_i]PNR_i .$$

Thus, a method and apparatus for determining load level in a communication system has been described. The method and apparatus according to various exemplary embodiments excludes the necessity to decode the data channel for determining the data rate. The data rate is independently determined based on the RRI channel information. Since the RRI channel is inherently at a low data rate and transmitted at an adequate power level, its reception and proper decoding of the RRI information are far more reliable than decoding the data channel. The load and rise values are used to determine whether to deny or allow communication access to a MS as a way to control the reliability of the communication serivces provided to other users in the

coverage area. The data rate of at least one reverse link may be reduced to bring the load level to a low percentage operating region.

The previous description of the preferred embodiments is provided to enable any person skilled in the art to make or use the present invention. The various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without the use of the inventive faculty. Thus, the present invention is not intended to be limited to the embodiments shown herein but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

What is claimed is: